SHUTE & RICHIE

A Life Test of Refilled Carbon Lamps

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A LIFE TEST OF REFILLED CARBON LAMPS

BY

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AND

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THESIS

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IN

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

ROBERT LEE SHUTE and JAMES KING RICHIE

ENTITLED A LIFE TEST OF REFILLED CARBON LAMPS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Electrical Engineering

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Instructor in Charge

APPROVED: Ernst Berg

HEAD OF DEPARTMENT OF ELECTRICAL ENGINEERING

CONTENTS.

INTRODUCTION.

The carbon lamp is the most widely used of the incandescent type at the present time. Within the last few years several new varieties of these lamps have been invented, and these have a much higher efficiency than carbon filament lamps. They have however the disadvantage of higher first cost and the filaments are very fragile. Their introduction has seriously threatened the use of carbon lamps, and has led to efforts on the part of manufacturers to decrease the first cost of their product in order to better compete with the other varieties.

One method used to cheapen the cost of carbon lamps is to refill them. This process consists of taking lamps which have burned out and breakingaway enough of the glas s at the pointed tip to insert slender instruments into the bulb. These instruments detatch the filaments at the point where the carbon is fastened to the platinum leads.

The interior of the bulb is then cleaned with acid to remove the carbon which has been deposited there by the old filament. After the bulb is cleaned the new filament is inserted and brazed on the platinum leads. The lamp is then reexhausted and sealed.

In view of the fact that these refilled lamps have been quite widely advertised by several large manufacturers, it was thought that a test to compare them with new carbon lamps would furnish valuable information.

The lamps used in this test were selected from an assortment of 50 Safety refilled, 50 Economy refilled 50 Boston refilled and 50 Columbia new incandescent lamps. They were all of 16 candle power size and ordered direct from the manufacturers. After a careful prelininary test 25 of each variety were selected.

PRELIMINARY TEST.

The lamps were first numbered from one to fifty each lamp being given an index letter corresponding to the first letter of its name. They were then placed upon a low voltage approximately 60, which is sufficient to make the filament glow, but not so brightly but that it could be looked at with the naked eye. In this manner crooked or kinked filaments and small spots in the filament could be detected. At the same time, the lamps were examined as to the straightness of the tip and mounting, the solidity of the base, and the smoothness and regularity of the bulb.

The lamps were then tested for vacuum by placing them across the secondary of an induction coil in parallel with a 3/8 inch air gap. The degree of floresence detected in the bulb was graded according to seven selected lamps, showing the floresence due to the corresponding stages of vacuum. These lamps had been previously selected by the Department of Electrical Engineering.

The last preliminary test was the measurement of the candle power and current consumption of each individual lamp. This was done upon the three meter photometer bar by comparison with a standard lamp. This standard lamp had previously been carefully calibrated with three other standard lamps fron the Electrical Testing laboratories at New York. Only the mean horizontal candle power of each lamp was measured. The lamp tested was placed in an upright position at one end of the photometer bar, and its full normal voltage 110, was impressed. It was then rotated at about 180 revolutions per minute while the photometer screen was being adjusted. The standard lamp was placed in an upright position at the other end of the bar, care being taken to get it in line with the center of the bar, and exactly on a level with the test lamp . The voltage and

current of the test lamp were measured with standard laboratory instruments which were calibiated especially for the experiment. The adjustment of the voltage was obtained by means of a stove-pipe rheostat. The candle power of the lamp tested was calculated from the photometer screen readings by the usual law of inverse squares. The current consumption of each lamp was measured at the same time, in order that its efficiency in watts per candle power could be calculated.

From the results of these preliminary tests, the lamps for the life test were selected all lamps whose filaments exhibited any weak spots on low voltage, those which were unusually crooked or kinked, and also those which showed a poor vacuum were discarded. In selecting lamps according to their watts consumption, those which were nearest the average were chosen.

Diagram Showing Rating of 25 Boston Refilled Lamps

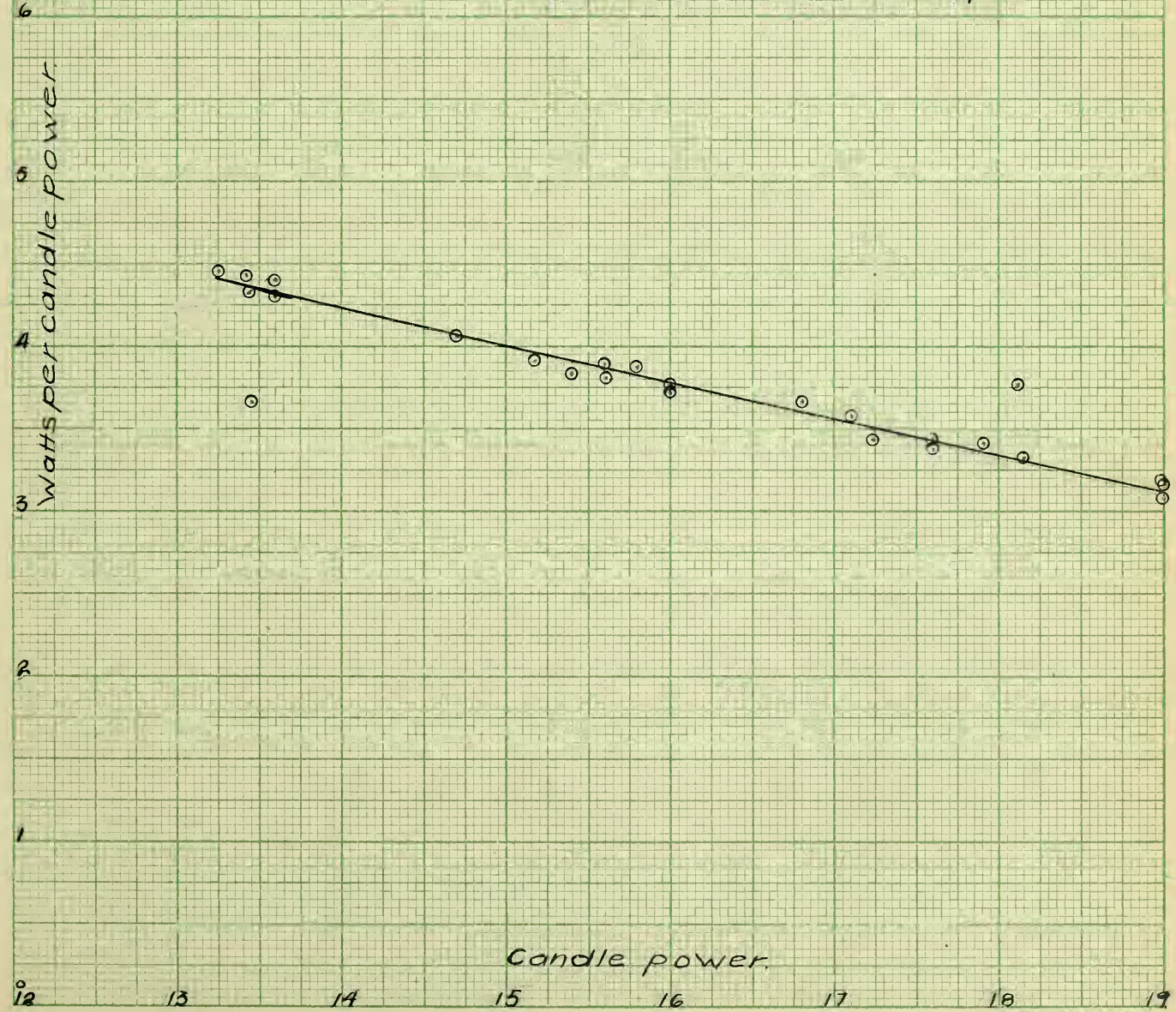
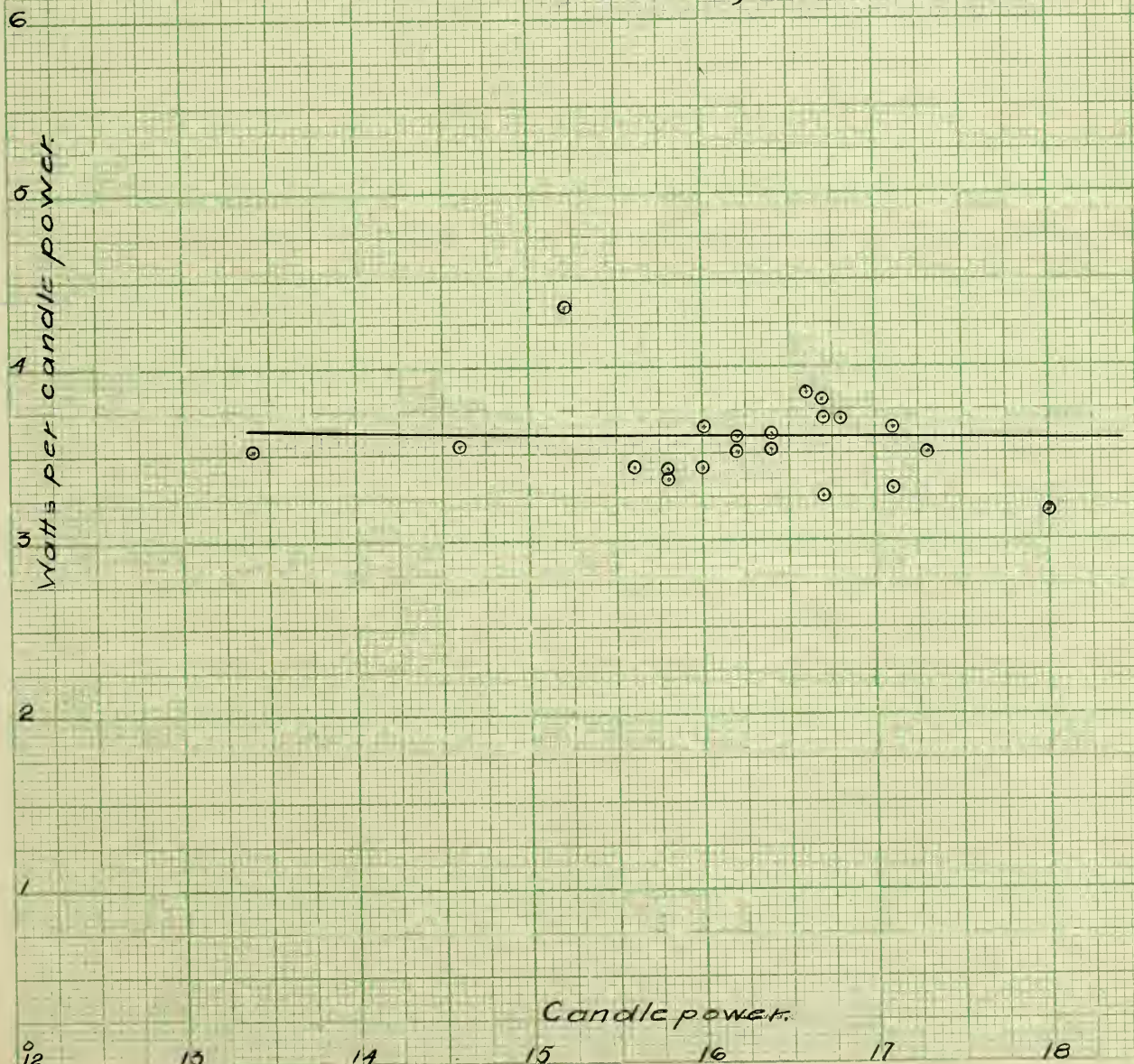


Diagram Showing Rating of 25 Economy Refilled Lamps



U. OF I. S. S. FORM 3

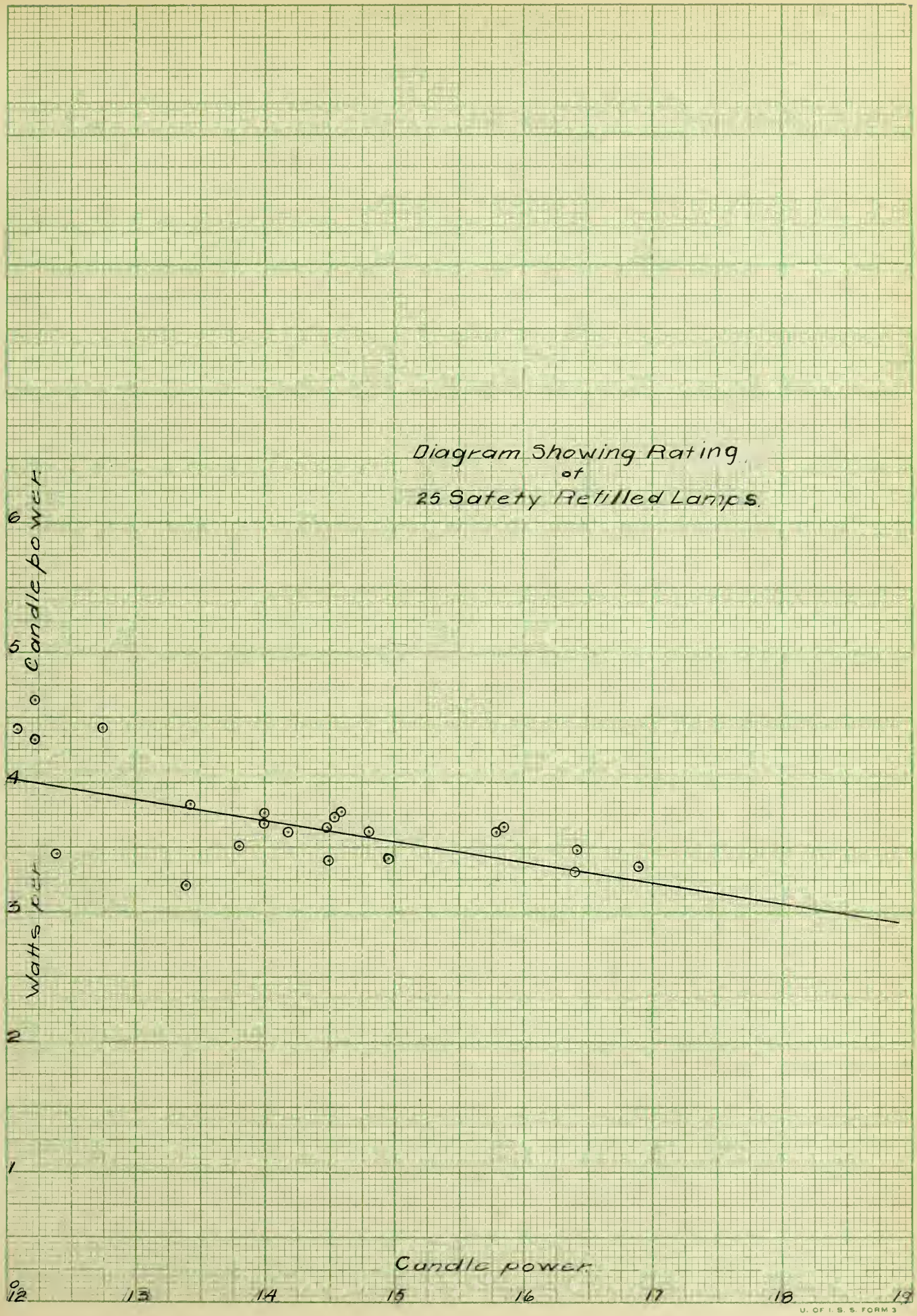
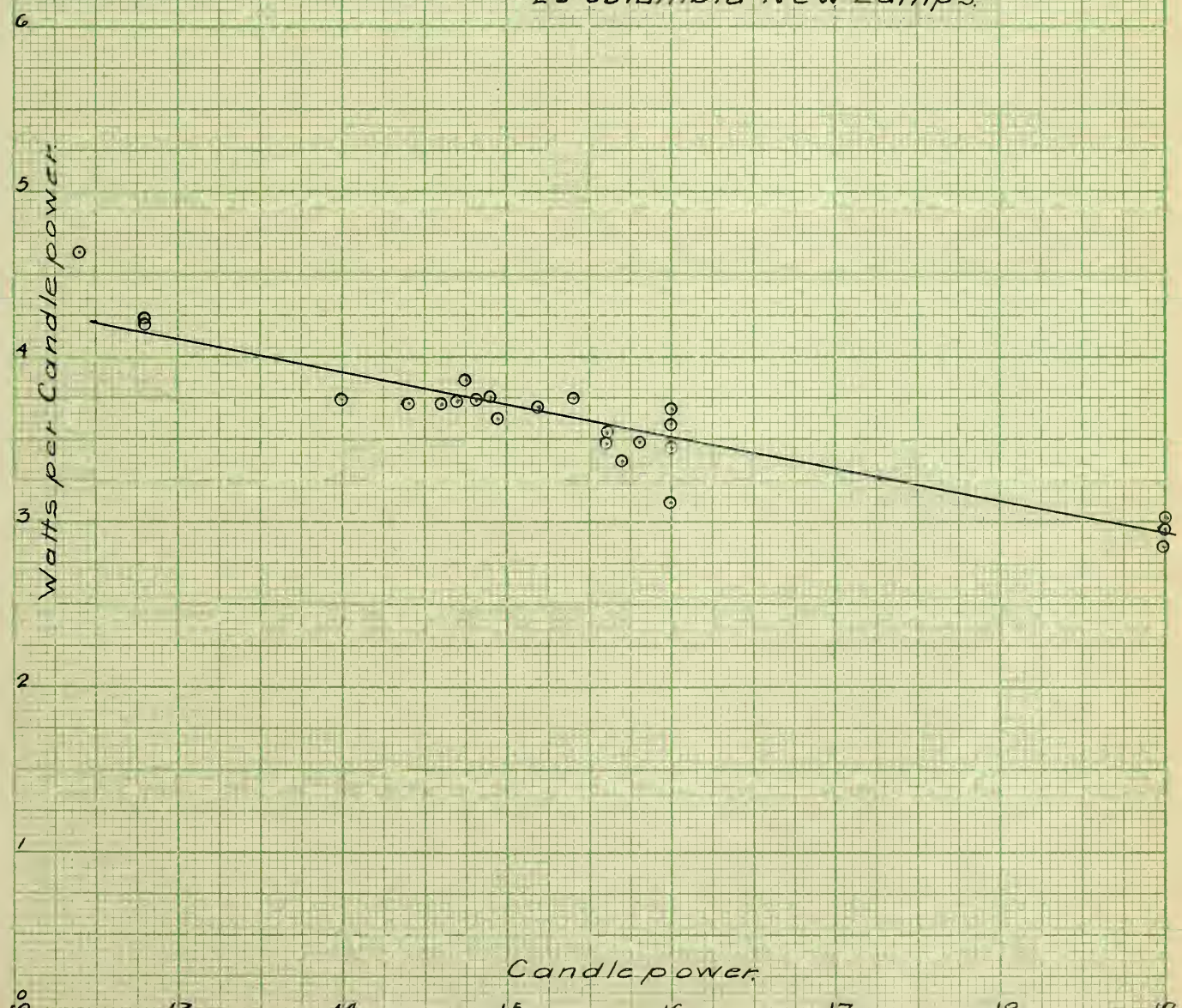


Diagram Showing Rating of 25 Columbia New Lamps.



U. OF I. S. S. FORM 3

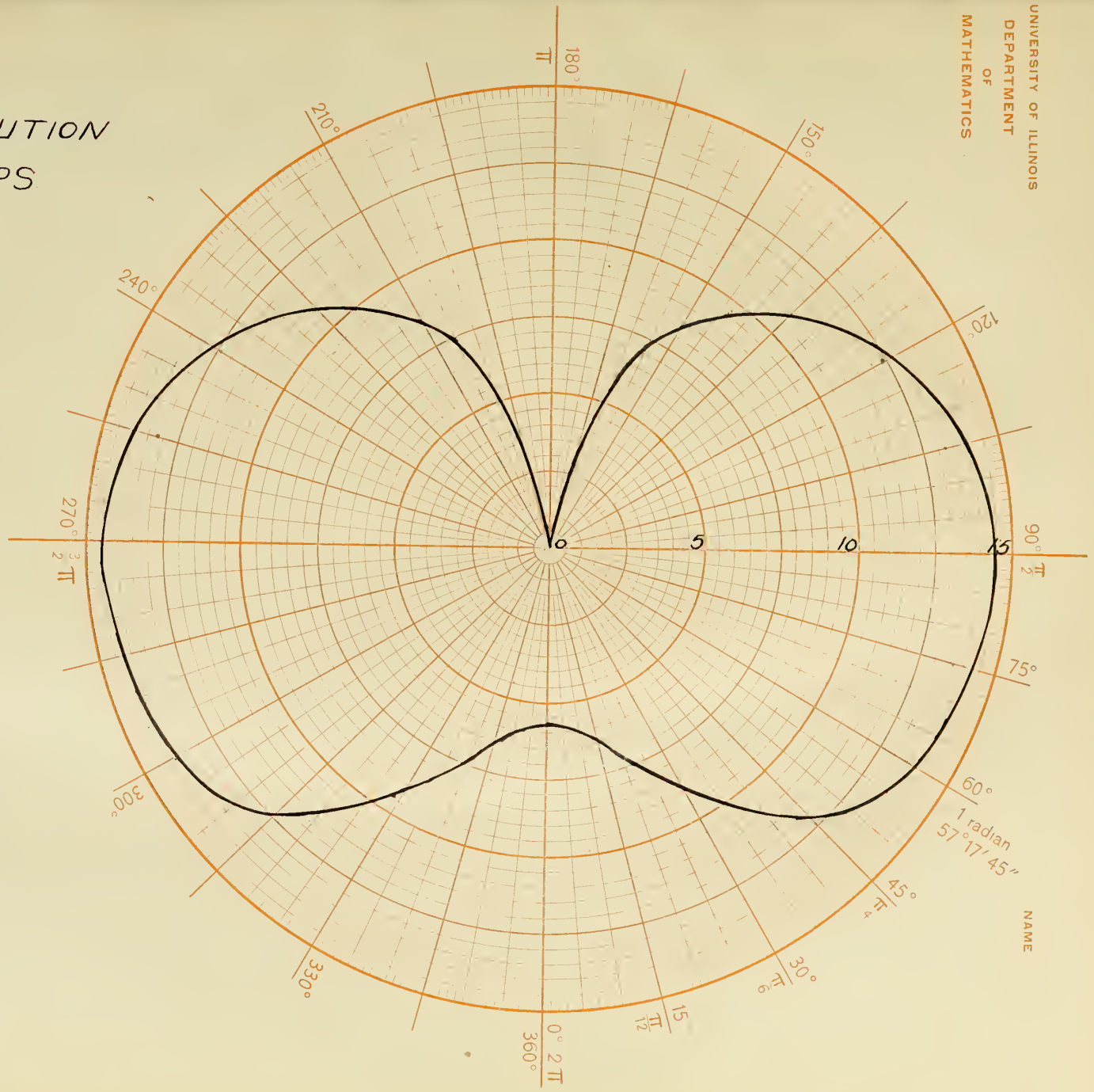
Distribution Curves.

The vertical distribution curves are shown by the accompanying figure . That for the Boston shows the poorest distribution. The curves are approximately three quarter circles, the tip candle power being greatest and the distribution curvethe most perfect in case of the Columbia lamps.

The curves showing the rating are all very similar. That of the Economy is very uniform although its average value is almost exactly the same as the other three varieties. The uniformity of the candle powers at the start also agrees with the rating.

VERTICAL DISTRIBUTION OF COLUBIA LAMPS.

VERTICAL DISTRIBUTION OF ECONOMY LAMPS



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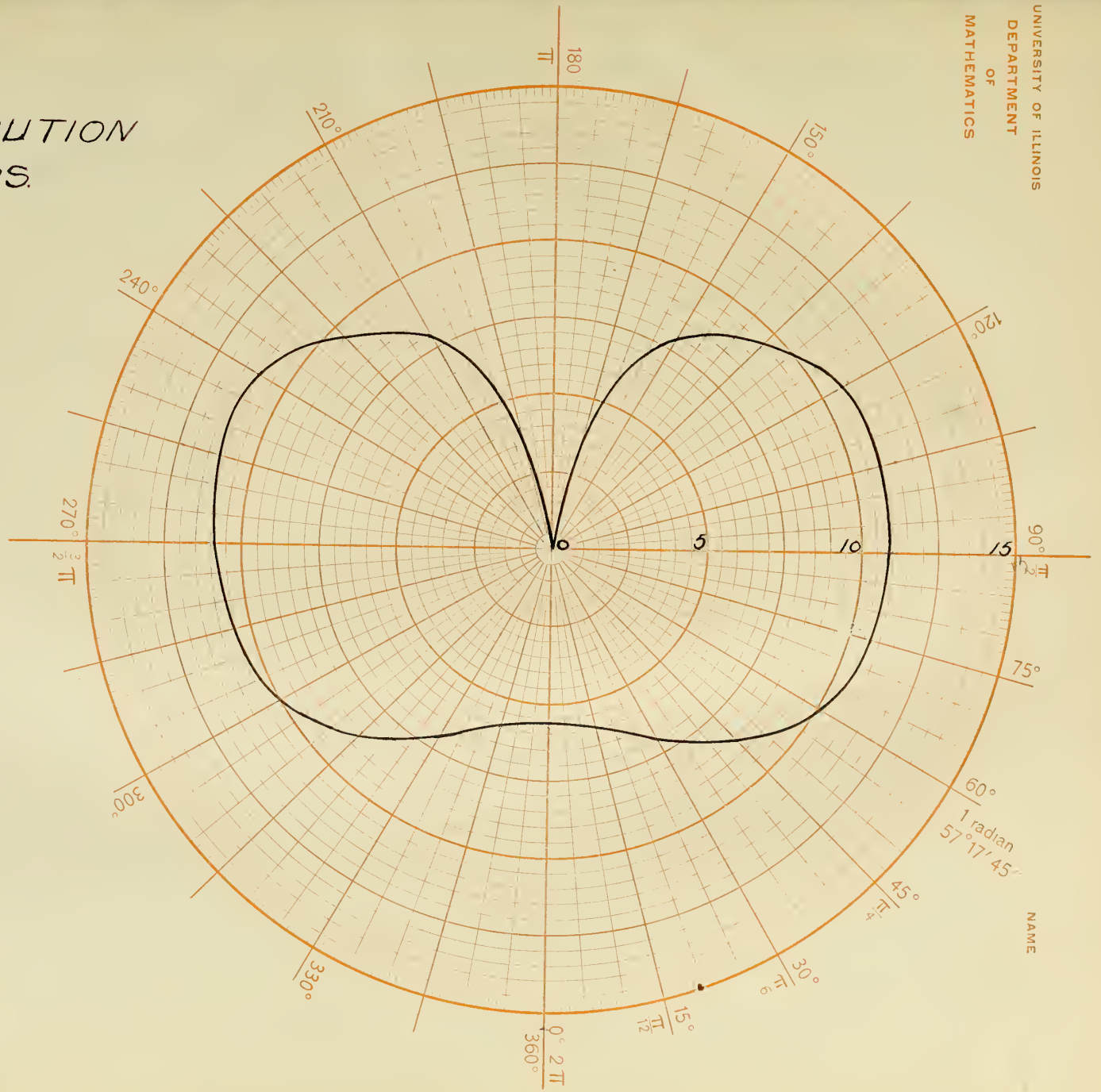
VERTICAL DISTRIBUTION OF BOSTON LAMPS.



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DEPARTMENT
OF
MATHEMATICS

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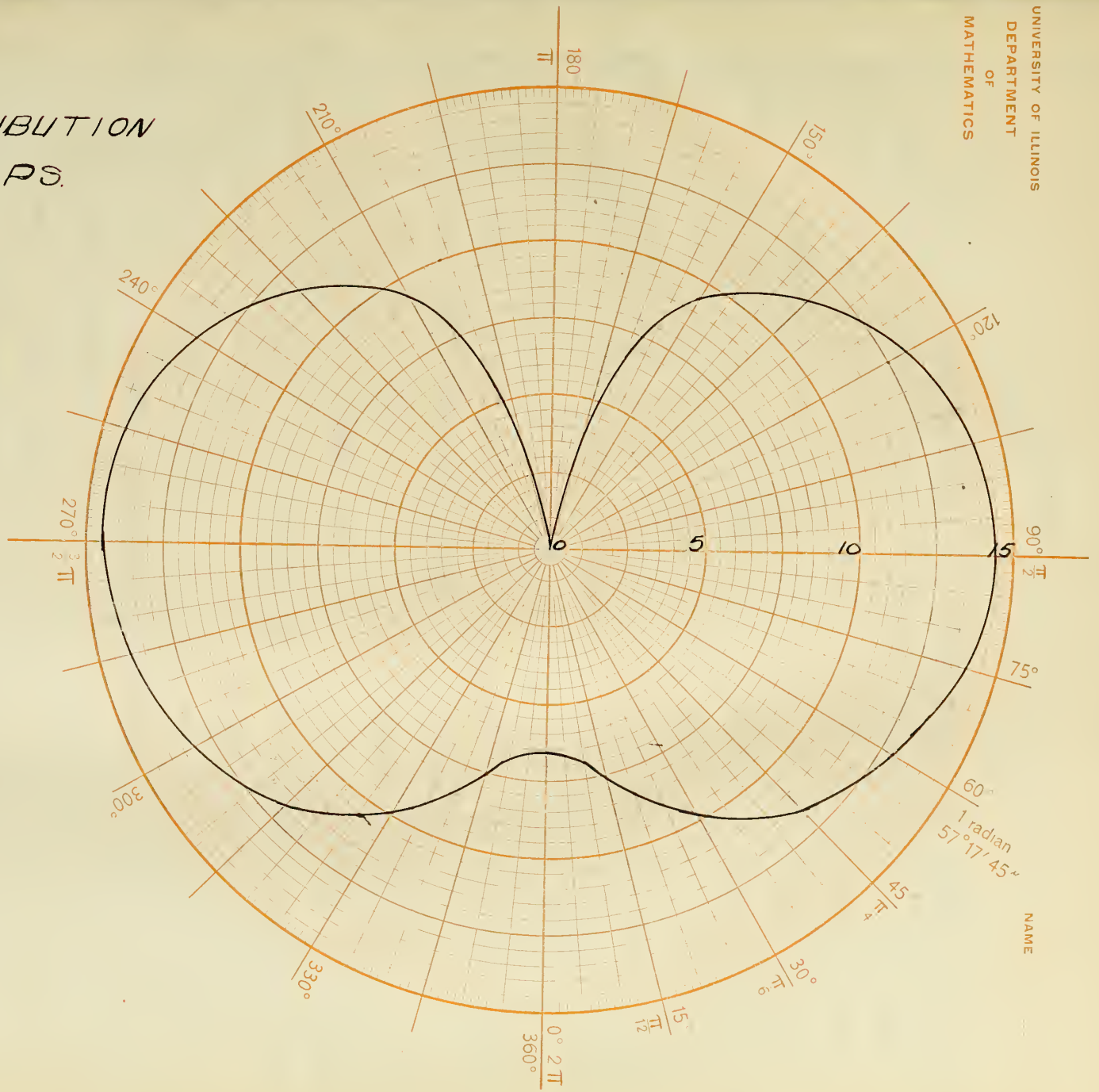
VERTICAL DISTRIBUTION OF SAFETY LAMPS.



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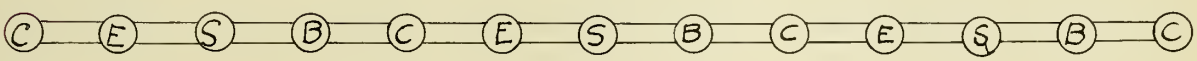
LIFE TESTS.

After the final selection had been made, the lamps were placed in lamp banks in the attic of the Electrical Building. The lamps were arranged in the banks as is shown in the accompanying diagram. This arrangement gave equal heating effect and equal voltsge drop to each of the different varieties. They were then placed in a vertical position with the tip downwards and kept in the same relative positions throughout the test, but not in the same sockets. The current was truned on at 9 P.M.March 24 1910 and the test continued for 1100 hours. The candle power and current consumption of each was measured after approximately the following periods:- 25, 75, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000 and 1100 hours.

In order to insure a very nearly constant voltage, the current was supplied by the storage battries. The battries were continually charged by " floating" them across the power plant. A rheostat was also placed in the circuit for a fine adjustment of the voltage. There was some vibration of the lamp bank due to the machinery in the building,but no more than could be expected under ordinary conditions.

At the expiration of 1100 hours twenty-three of the twenty-five Boston, twenty of the twenty-four Columbis, seventeen of the twenty-five Safety and seventeen of the twenty-four Economy lamps were burning.

In examining the data from the test it is seen that two of the Safety lamps, all of whose conditions, base, mounting of filament, tip, bulb and vacuum were good at the start, burned out after 100 hours. These lamps burned out because of air which had gained access to the bulb, when they were placed in the socket for measuring the



ARRANGEMENT OF LAMPS IN RACKS

B - BOSTON

C - COLUMBIA

E - ECONOMY

S - SAFETY

candle power.

This was true in the case of the Economy lamps one of which burned out at three hundred hours, two at four hundred hours. The filaments of two of the lamps were somewhat crooked but the vacuum was good. Of the Boston lamps one had burned out at four hundred hours, with all its conditions good at the start.

In view of these facts, and the fact that none of the Columbia lamps failed before seven hundred hours of burning, it would seem to be a rational conclusion that the cement holding the glass in the base had weakened with age. As it was necessary to screw the lamps into the socket and remove them several times, the cement had cracked during the handling and allowed air to enter the bulb. Those that failed after longer periods of burning showed marked discoloration as if the filament had thrown off particles of carbon until it became so small, that its resistance increased enough to cause it to burn out.

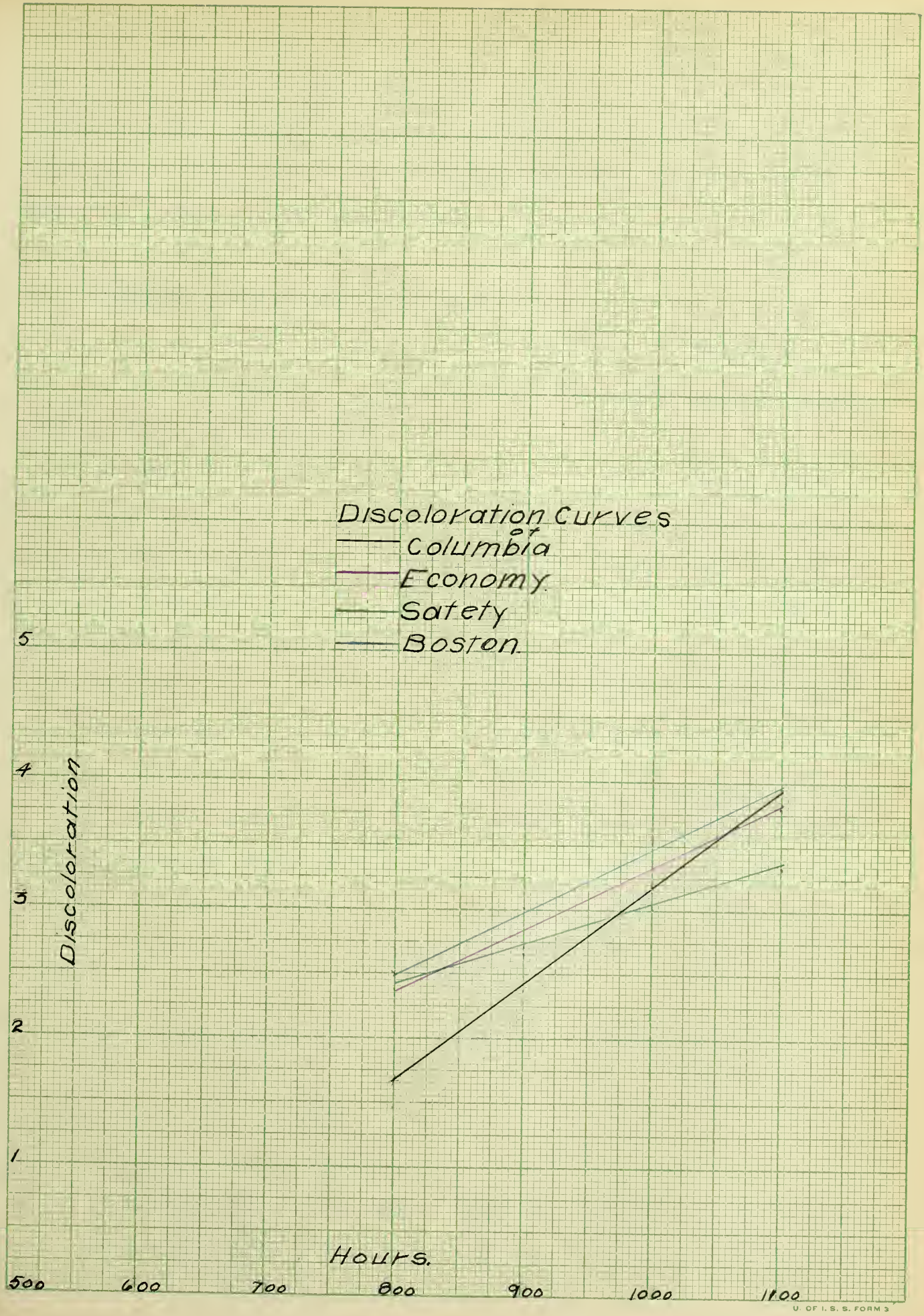
CANDLE POWER MAINTENANCE AND CHANGE IN EFFICIENCY.

The curves giving the average values of the candle power, show the usual performance for carbon lamps in case of the Columbia new lamps. The three varieties of refilled lamps all show exactly the opposite case to that of the Columbia's during the first seventy-five to one hundred hours. From the initial candle power they fall off several percent, rising afterward to their maximum value. As might be expected with falling candle power their watts per candle rise, fall when the candle power increases, and rise again as the lamps decrease in brightness later on.

Of the four varieties, the new lamps maintain a higher candle power throughout the test and their current consumption is also the lowest.

The Economy lamps give the next best results, the candle power and watts per candle curves lying next to the Columbia. The Boston lamps come next and the Safety last. Until 900 hours the lamps all have an efficiency of about 75%, but from this point on, they fall so rapidly that it would not be profitable to burn them.

After the lamps had burned 300 hours, they were compared with a series of ten lamps, showing various stages of descoloration. These standards had been burned for different periods of time,and hence showed carbon deposits of different densities on the bulb. They ranged indensity from 95 per cent of the original candle power down to 66.9 percent, and were numbered from .5 to 5. The lamps were compared with these standards every 100 hours, and from these observations the rapidity with which they blackened could be determined. The accompanying discoloration curves are plotted between the average



blackness of the lamps, burning at the time of taking each reading, and hours. They blackened uniformly but with various rates. The Columbia lamps blackened the most rapidly. This might be expected from their candle power curves, which also fall off more rapidly than the other lamps during this period.

SUMMARY OF LIFE AND EFFICIENCY TESTS.

Lamps	New : Columbia	Boston	Refilled Safety	Economy
Average Mean Horizontal C.P.				
a. New	15.1	16.1	15.1	16.1
b. 500 hr.	15.0	14.6	13.2	14.5
c. 700 hr.	14.8	14.1	12.3	14.1
d. 1000 hr.	13.0	12.3	11.4	12.5
Average Watts per C.P.				
a. New	3.9	3.8	3.85	3.55
b. 500 hr.	3.95	4.30	4.03	4.00
c. 700	3.95	4.20	4.25	4.04
d. 1000 hr.	4.75	4.82	4.70	5.20
Average Watts per C.P.				
a. through 500 hr.	3.69	3.91	3.98	3.73
b. through 1000 hr burning	3.88	4.12	4.15	3.98
Average C.P.				
a. through 500 hr.	15.8	15.9	13.8	15.6
b.through 1000 hr.	15.1	14.9	13.1	14.8
Average Watts per C.P.in% Taking Columbia equals 100%				
a. through 500 hr burning	100%	105.9%	107.8%	101.1%
b. through 1000 hr.burning	100%	106.2%	107.2%	102.6%

Lamps	New Columbia	Refilled Boston	Refilled Safety	Refilled Economy
K.W.hours due 16 C.P. lamps.				
a. 500 hr.	29500	31300	31800	29800
b. 1000 hr.	59000	62600	63600	59600
Cost of operation plus cost of lamps, of one 16 C.P.lamp.				
a. 500 hr at 10cts.per K.W. hr	$3.11	$3.21	$3.26	$3.06
b. 1000 hr at 10cts per K.W.hr	$6.06	$6.32	$6.44	$6.04
Cost of operation plus cost of lamp, of one 16 C.P.lamp expressed as Columbia as 100%				
a. 500 hr	100	103.2%	104.8%	98.5%
b. 1000 hr	100	104.3%	106.3%	99.7%
First cost of lamp	16 cts.	8 cts.	8 cts.	8 cts .

The Economy and Boston lamps seemed to blacken at the same rate and their candle power also fell off proportionately. The "Safety" lamps must have blackened rapidly at the start as their candle power fell off at the start and continued to fall until the termination of the test. A summary of the performance of the lamps on the life and efficiency test is shown by the accompanying table. Considering the cost of power for a single lamp of each variety, and putting the first cost of the new lamps at 16 cents each and the refilled at 8 cents each the results show that the Economy lamps were somewhat more economical than the Columbia, but the other two varieties were more costly. At one thousand hours the results are very nearly the same, being a little more

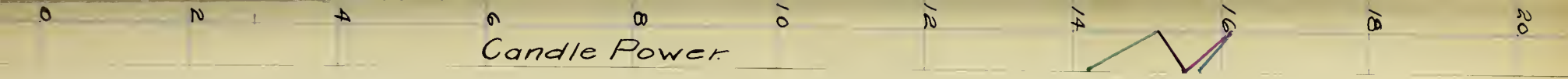
more favorable to the new lamps. It would seem that the slight difference in cost between the best of the refilled varieties and the new lamps would hardly counterbalance the greater reliability and uniformity of new lamps.

CONCLUSIONS.

From a comparison of the candle power time curve of the new Columbia lamps, with curve showing the performance of similar lamps under the same conditions, it is found that the results are the same. The refilled lamps do not follow any law during their first 100 hours of burning. Their performance is simply erratic, and no cause can be ascribed to it, except that they are more unreliable than the new lamps.

The candle power of the refilled lamps is less than the new lamps and their watts per candle is in all cases greater. As a rule the filaments of the refilled lamps were more kinked and showed more unevenness than the new ones. This vacuum was not so good and their tips and mountings more distorted. The initial cost of refilled lamps is about one half that of new lamps, but this decreased first cost is more than counterbalanced by their increased current consumption and generally more unsatisfactory performance except in case of the Economy. In this case the costs of operation are very nearly equal although the Economy lamps gave more failures early in their life than the Columbias.

The comparison would be fairer if a set of new lamps was burned with each set of refilled lamps. The performance of the Columbia lamps, however, is typical, as was found by comparing the results of this test with others carried on under the same conditions. Therefore if the conclusions reached favor the new lamps at all they do so very slightly.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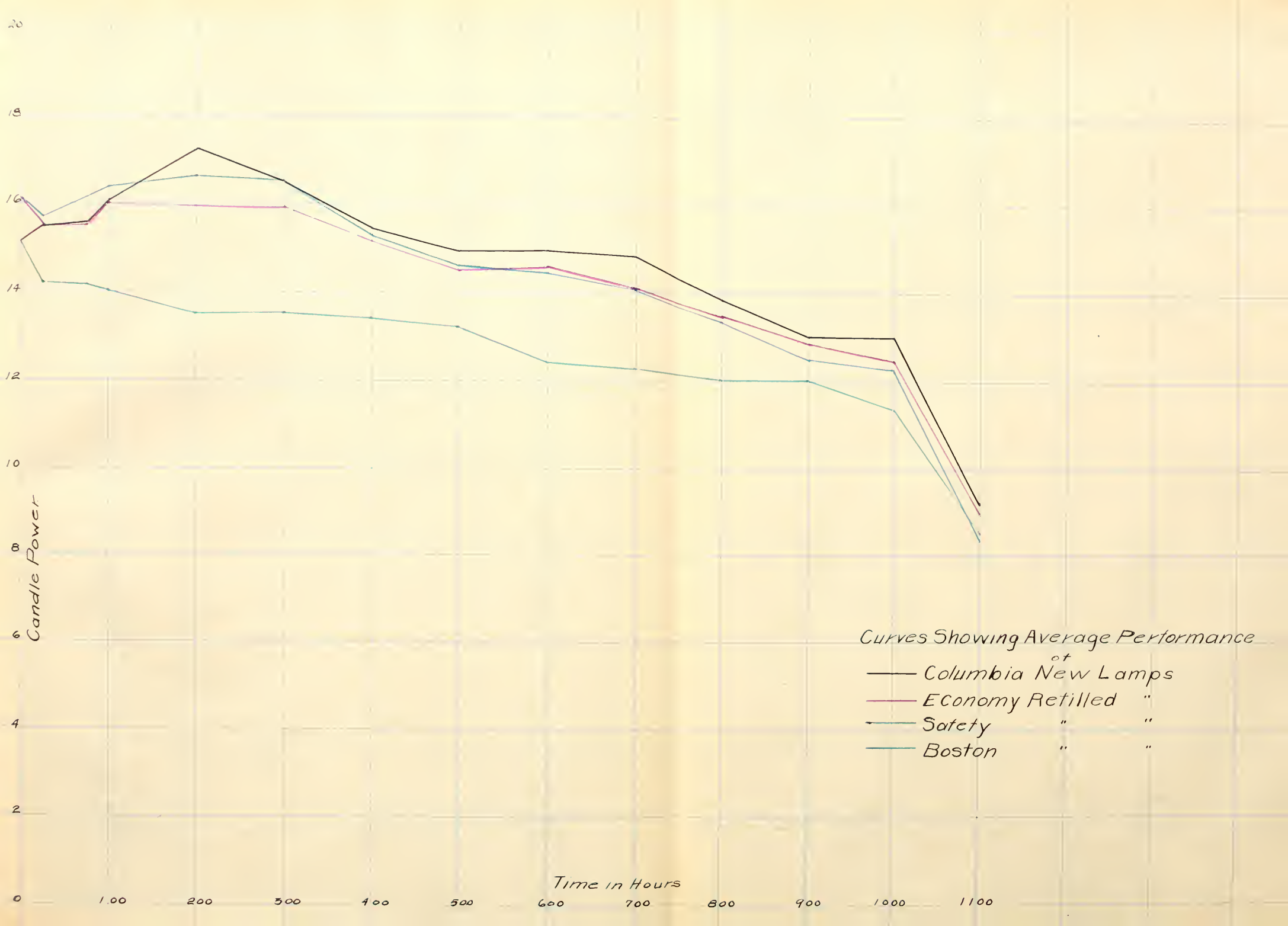
Candle Power.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Candle Power
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Time in Hours
Curves Showing Average Performance of
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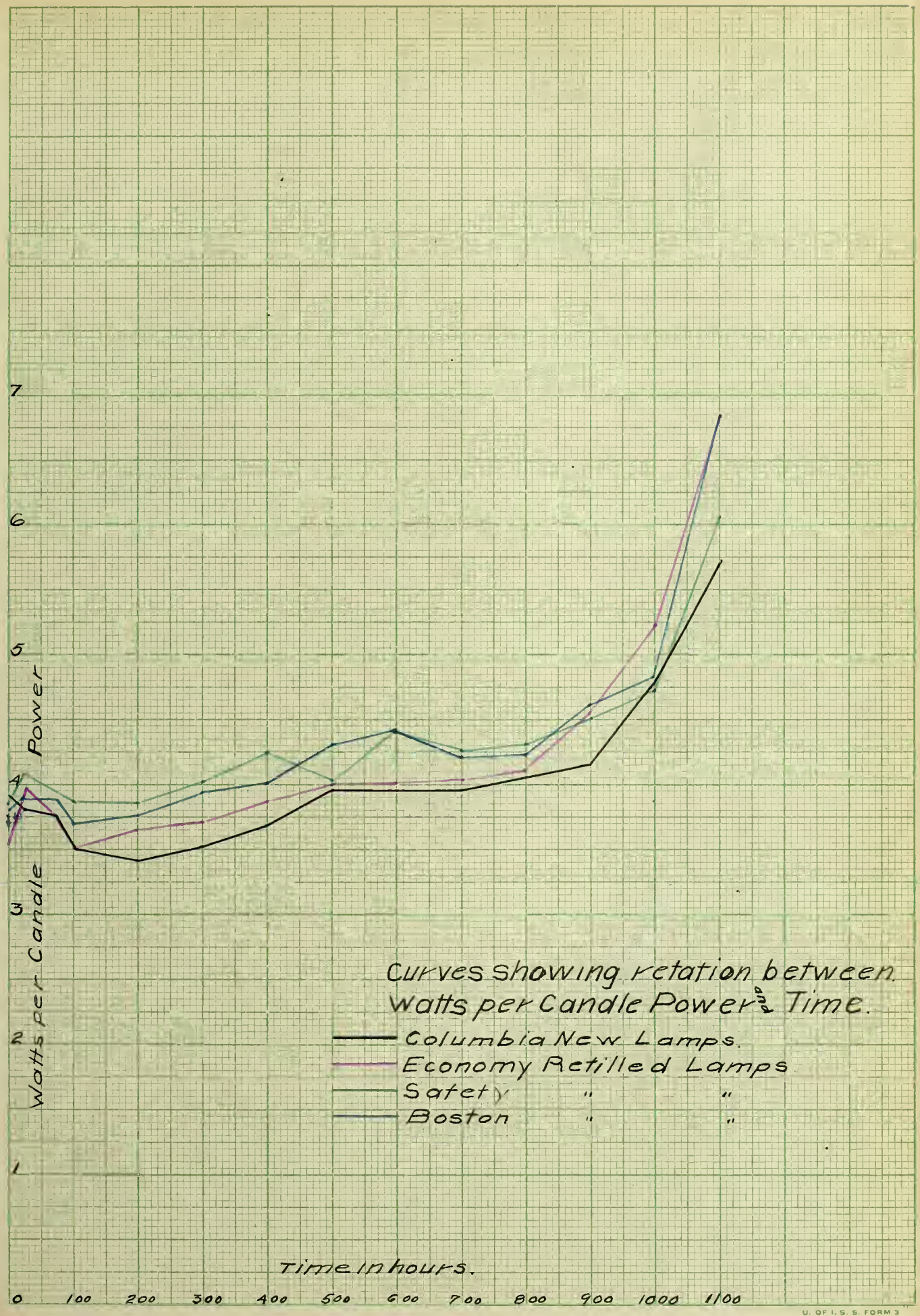
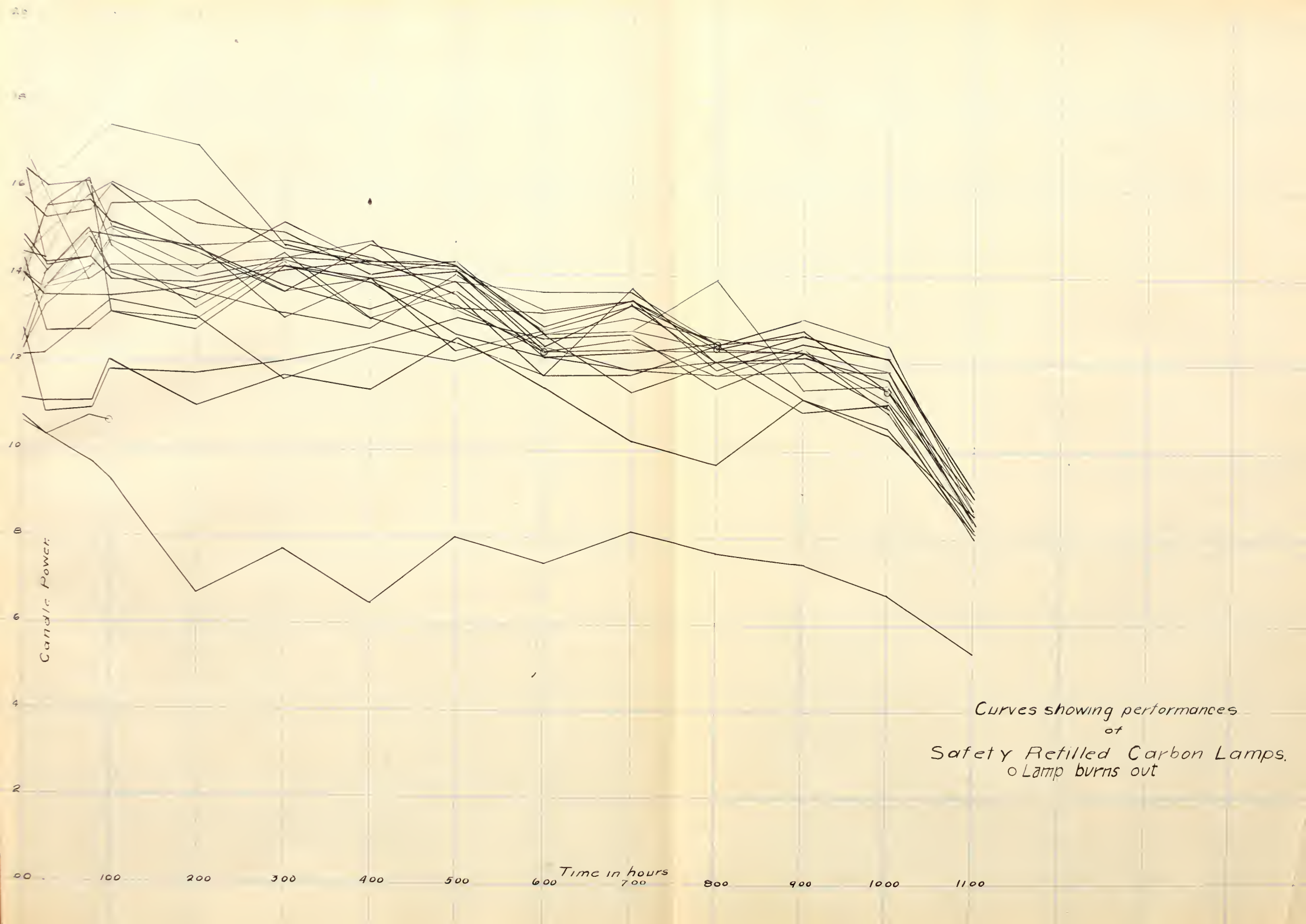
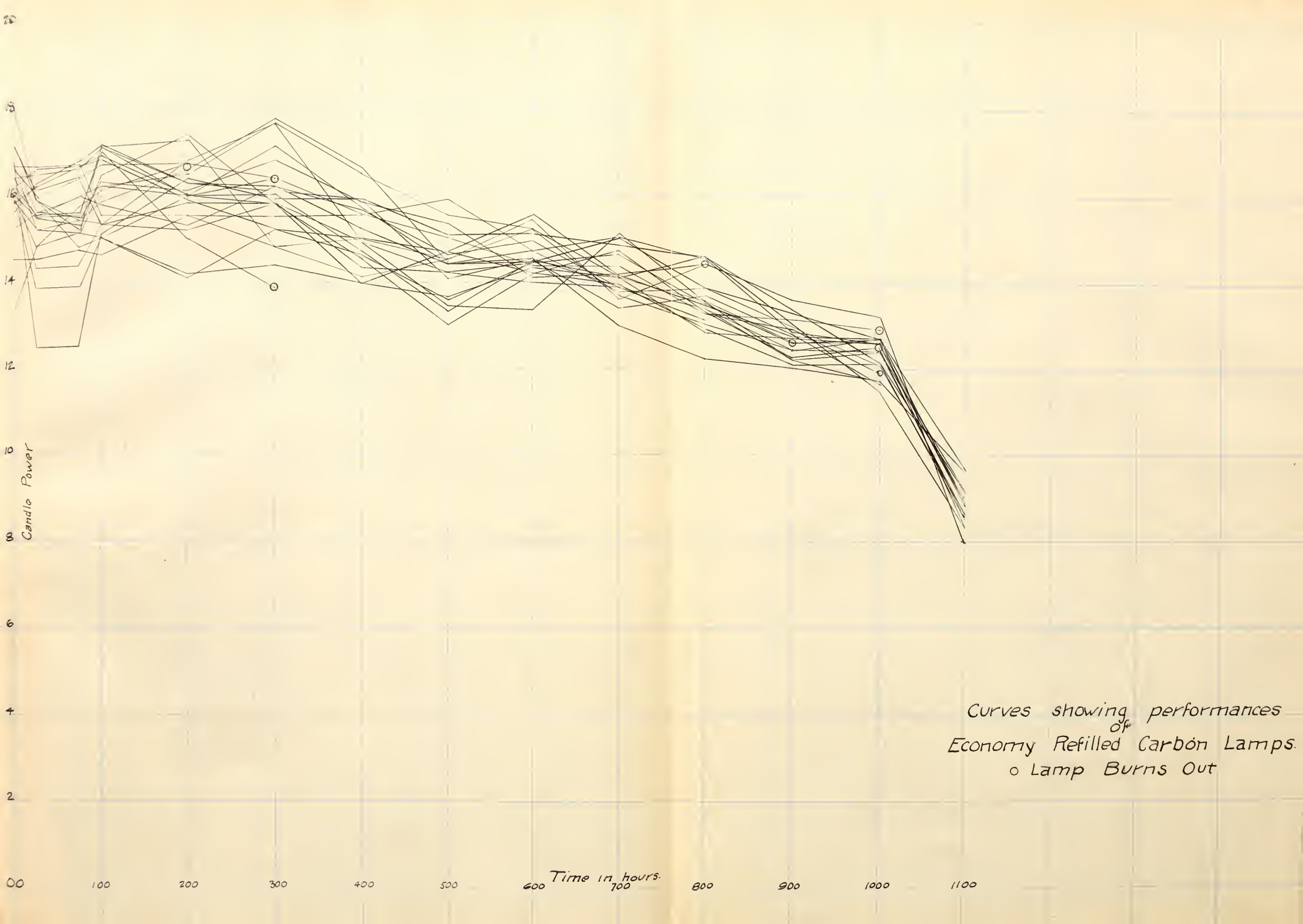
Economy Refilled "
Safety " "
Boston " "





Curves showing performances
of
Safety Refilled Carbon Lamps.
o Lamp burns out


Candle Power
Time in hours.
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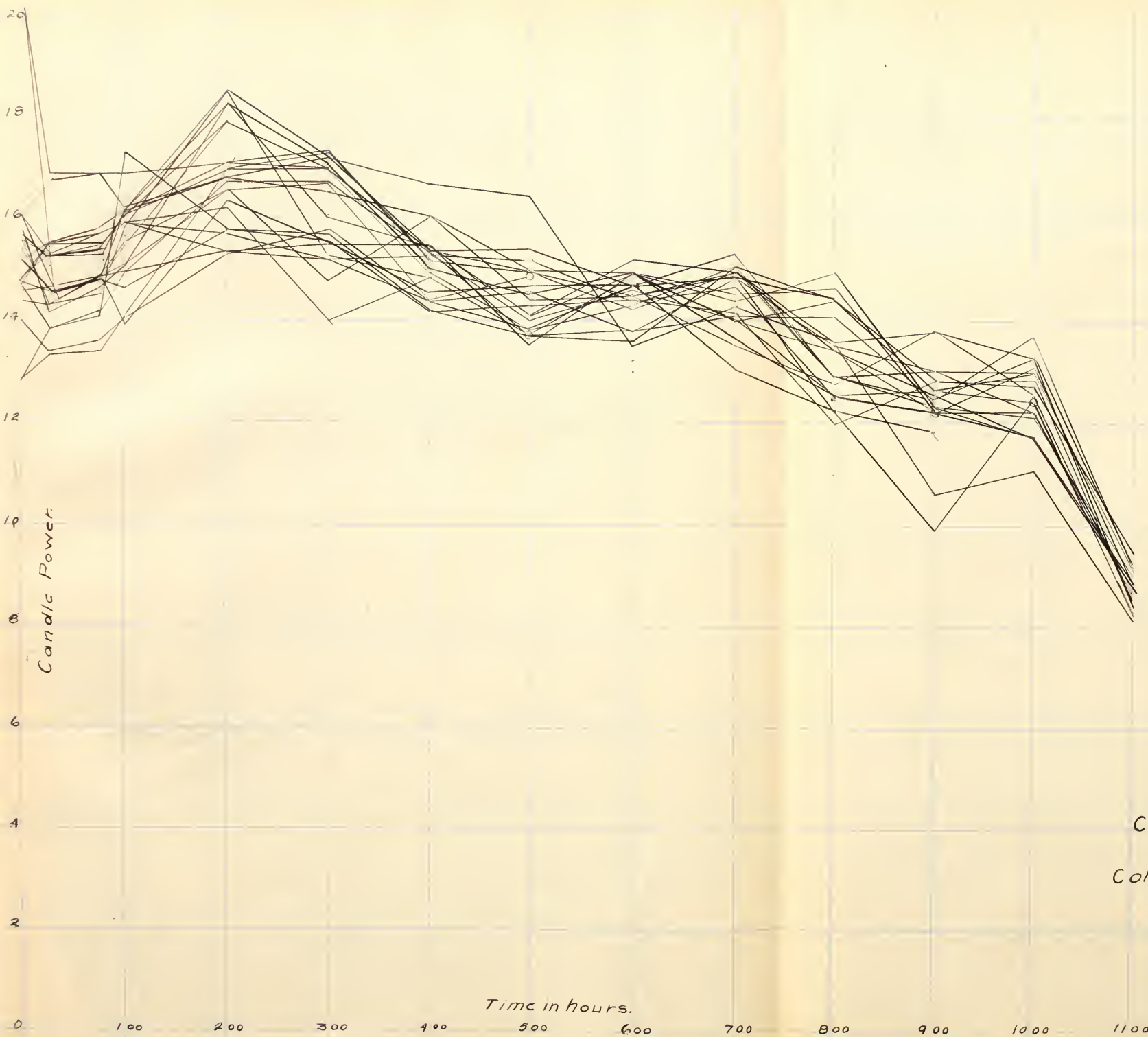
Curves showing performances of Economy Refilled Carbon Lamps.
o Lamp Burns Out



Curves showing performance
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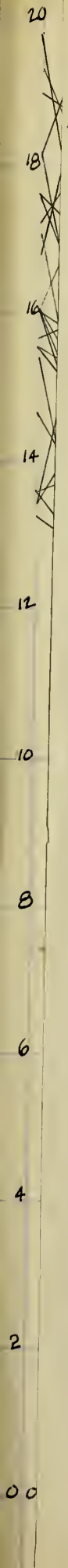
Columbia New Carbon Lamps
o Lamp Burns Out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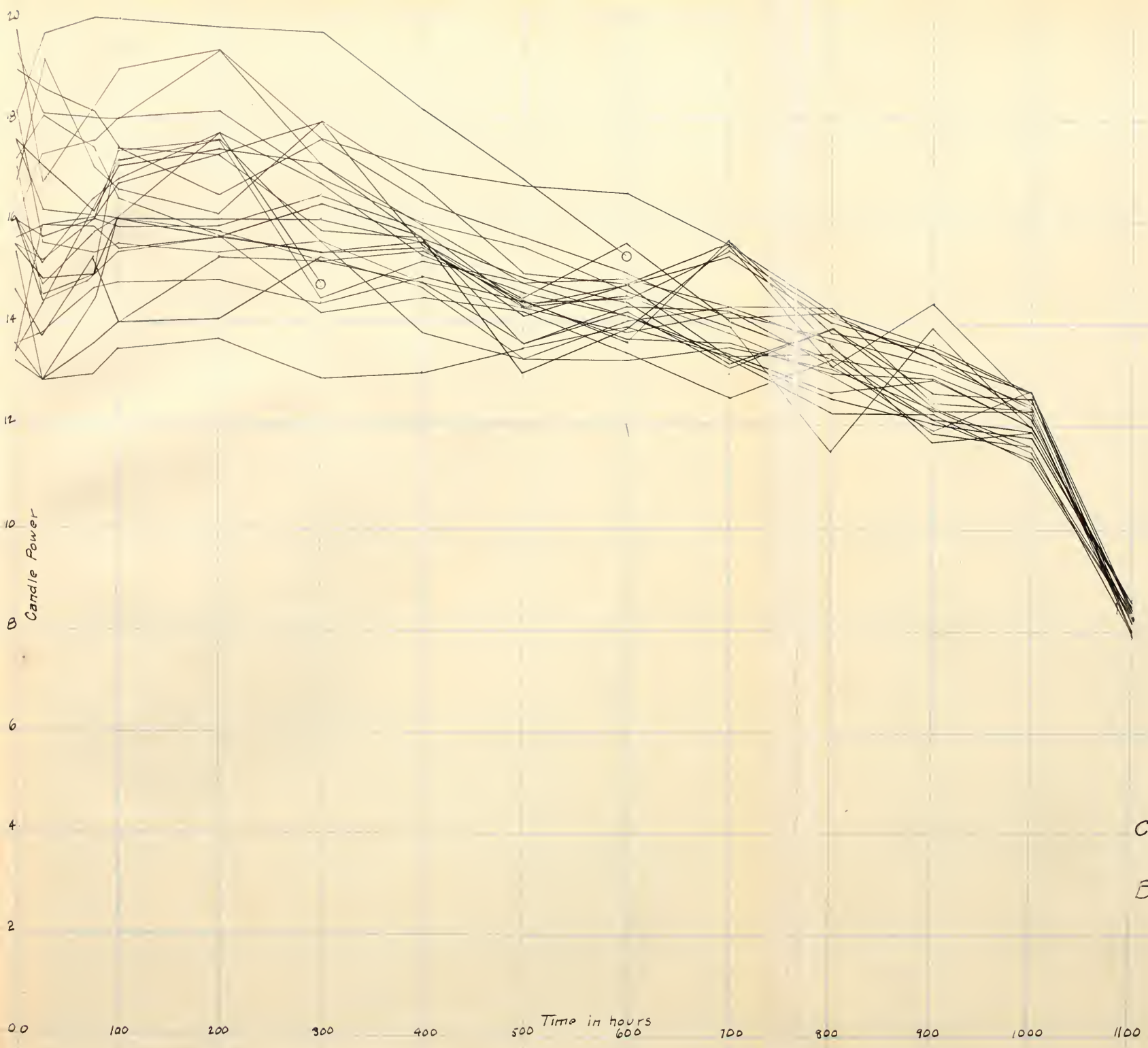

Curves showing performances
of
Boston Refilled Carbon Lamps.
o Lamp burns out

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